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Market Perception of Defense Mergers in the United States, 1990-2006: A Case of Event Studies

26 November 2007

by

Jennifer L. Grant, Maj., USAF

Advisors: Dr. Nayantara Hensel, Assistant Professor, and
Dr. Keith Snider, Professor

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Prepared for: Naval Postgraduate School, Monterey, California 93943

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Abstract

The purpose of this paper is to examine and analyze whether or not there was a statistically significant reaction in financial markets to the announcements of US defense contractor consolidations (mergers and acquisitions) from January 1990 to December 2006. This analysis is conducted through the use of two series-of-event studies (employing first the arithmetic and then the logarithmic returns against the S&P 500 index) involving the top five defense contractors: Boeing, Lockheed Martin, General Dynamics, Raytheon and Northrop Grumman.

Many studies have been conducted using the event-study methodology, and the results have shown in some cases that stock prices do respond to new information. The assumption has been maintained that the market responds rationally to such announcements. In contrast, the announcements of the acquisition of publicly traded firms by other publicly traded firms have not always had a consistently significant beneficial effect on the shareholder wealth of the acquiring firms (Schipper & Thompson, 1983). Results of this case study further support the latter assertion and add to the body of research involving event studies.

Keywords: defense industry, consolidations, mergers, acquisitions, event study, event studies

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Jennifer L. Grant

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Disclaimer: The views represented in this report are those of the author and do not reflect the official policy position of the Navy, the Department of Defense, or the Federal Government.

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I. Introduction

A. Purpose

After the end of the Cold War, the aerospace and defense industry in the United States experienced considerable consolidation between 1990 and 2000, thereby reducing the number of major defense contractors to a small handful. This consolidation trend has continued into 2006. As a result of these aerospace and defense mergers and acquisitions, many policy questions have examined whether economic efficiencies have been gained, whether the US Department of Defense has benefited or been economically disadvantaged by the decrease in industry competition, and whether the industry contractors involved in the consolidations have gained greater financial advantages as a result of the consolidation. A key component of whether the defense industry consolidation in the United States led to improvements in the financial performance of defense contractors is the market's perception of the value created by the consolidations. This perception of value is reflected in statistically significant reactions in the financial market value of the respective company's stock.

The purpose of this paper is to examine and analyze whether or not there was a statistically significant reaction in financial markets to the announcements of US defense contractor consolidations (mergers and acquisitions) from January 1990 to December 2006. Two series of event studies were analyzed, employing first the arithmetic and then the logarithmic returns against the S&P 500 index, and involving the top five defense contractors: Boeing, Lockheed Martin, General Dynamics, Raytheon and Northrop Grumman.

B. Scope and Organization of Research

The scope of this project is focused on the aerospace and defense industry's top five defense contractors. This determination of the ranking companies is based on defense-sector market share and the number of defense contracts awarded. The

determination of these companies as the top five is consistent with the *Annual Industrial Capabilities Report to Congress*, as submitted by the Office of the Under Secretary of Defense, Acquisition, Technology and Logistics Industrial Policy (DoD, 1997-2001, 2001-2003, 2005 and 2006 reports). Additionally, these five defense contractors have survived over a decade of mergers and acquisitions and serve as an excellent baseline for the event studies.

The event studies included in this research effort involve a total of 125 merger and acquisition announcements and approximately 250 regression analyses using arithmetic and logarithmic returns for both the respective company securities and the S&P 500 index. The announcements of the respective contractor firms were obtained from the Bloomberg database and verified by the respective corporate press releases documenting the announcements. Table 1 lists the breakout by contractor and then sums the number of required regression runs.

Contractor	Number of Announcements
Boeing	**19**
Lockheed Martin	**25**
General Dynamics	**36**
Raytheon	**18**
Northrop Grumman	**27**
Totals	**125**
# Regression Runs	**250**
Arith + Log Returns	

Table 1. Summary of Contractor Consolidation Announcements and Data Runs

The scope of the event studies involves all Bloomberg database-documented and corporate press-release-verifiable consolidation announcements made between January 1990 and June 2006. Several of these announcements involve equity

acquisitions and physical asset acquisitions, and these are noted where applicable. In select cases, a date was found in Bloomberg but was not verifiable by any other corporate or public source. In these select cases, the announcement was omitted from the study to maintain the integrity of the verified dates listed. Any such omissions are noted and documented in Chapter IV of this paper. The inferences and conclusions drawn from the event studies reflect only the scope of the project described herein.

This paper is organized into several sections, and the next section in this chapter will address the application and benefits of this research in a general sense. Chapter II provides an overview of background information, beginning in Section A, with a brief discussion on terminology; Section B continues with a commentary on the historical background and review of literature involving the aerospace and defense industry consolidation from 1990-2006.

Chapter III details the methodology used for this research. Section A provides additional information in selecting the defense contractors involved in this case study; Section B provides the recipes for the event studies using the arithmetic and logarithmic returns. Section C closes Chapter III by explaining the method of analysis used to interpret the data results from the regressions run in the event studies.

Chapter IV includes the data results from the event studies completed for each contractor and provides the statistical data in tabular format for analysis. Chapter V follows with the overall summary inferences and conclusions drawn from the data outlined in Chapter IV. Chapter VI concludes with recommendations for future research.

C. Application and Benefit of Research

This research provides quantitative, statistically significant data to assist in addressing questions like, “Did the defense mergers in the United States lead to improvements in the financial performance for defense contractors?” and “What was

the market's perception of the value created from the industry consolidation?" Although the results from this case study are only germane to the top five defense contractors in the United States, the results do provide data on the strength and frequency of statistically significant abnormal returns on the respective company's daily stock price. This in and of itself supplies a glimpse of the market's perception of the anticipated value created by the US defense industry consolidations involving Boeing, Lockheed, General Dynamics, Raytheon and Northrop Grumman.

The data gathered from this research can be used as the baseline for comparison when examining pre- and post-merger trends in the respective company's financial performance. By examining the ex-post data in light of the market perceptions of the individual US defense contractor consolidations, researchers are then able to infer whether or not the market's statistically significant perception of the merger or acquisition became a reality for the company in question.

Additionally, the results from this research provide policymakers with quantifiable and unbiased data with which to determine the benefit or loss the companies experienced through these acquisitions and mergers. This information would be useful in determining future policy with regard to additional defense contractor mergers and acquisitions (i.e., should the DoD encourage or discourage mergers and acquisitions). During the mid-to-late nineties, there was much speculation as to whether the wave of mergers and acquisitions were beneficial or harmful to the DoD and to the defense contractors. The results of this study shed some light on the issue. The application and benefit of the event study research is mentioned again and developed further in Chapter VI, where recommendations for future research are outlined.

II. Background Information

A. Terminology

Throughout the course of this paper, several key terms are frequently used, and it is helpful at this juncture to clarify their respective meanings as applied to this research effort.

1. Acquisition

An acquisition refers to one company purchasing another. There is a clear acquirer, and the company purchased is referred to as the target. Acquisition is a general term and is used in conjunction with the term "merger" throughout this paper.

2. Merger

A merger, similar in nature to an acquisition, refers to the absorption by a corporation of one or more other corporations. Mergers are referred to as either being vertical or horizontal. A horizontal merger is simply the combination of two or more firms or corporations in the same line of business. Lockheed's acquisition of Martin Marietta in 1994 is an example of a horizontal merger. This study contains predominantly horizontal mergers within the US defense industry (Brealey, Myers & Allen, 2006).

A vertical merger involves companies at different stages of production. For example, the purchasing company may acquire a source of raw material; the purchases are made within the supply chain and can ultimately extend to the customer (2006).

The third type of merger is a conglomerate merger, which involves companies in unrelated lines of business (2006). The term "merger" in this study refers collectively to vertical and horizontal mergers, but it is not meant to imply conglomerate mergers.

3. Consolidation

The term “consolidation” technically means the unification of two or more corporations by dissolution of the existing corporations and creation of a single, new corporation (“Consolidation,” 1991). The wave of mergers and acquisitions beginning in the early to mid 1990’s is referred to as the consolidation, or the unification, of the US defense industry. As a result of the increase in consolidation, there were multiple unifications of industry corporations and a complete downsizing of the industry overall. This consolidation involved both acquisitions and mergers, and the term “consolidation” is used in reference to the merger and acquisition activities experienced by the corporations within the US defense industry.

4. Event Study

An event study is simply a term used to describe an analysis of whether or not there is a statistically significant reaction in a given financial market to a particular event that is hypothesized to affect the market value of a public firm. In this case, the announcement dates are referred to as “events.”

B. Historical Background and Literature Review

The US defense industry consolidation, beginning in the 1990’s and still occurring to date, has often been referred to as a wave of acquisitions and mergers. In their paper titled, “Catch a Wave: The Time Series Behavior of Mergers,” Devra L. Golbe and Lawrence J. White (1993) fit a set of sine waves to the annual time series data on mergers in the United States from 1900 to the mid-1980’s. They found the sine curves explain numerous trends. The most recent merger and acquisition wave they identified was that occurring in the early and mid-1980’s, and they term it the fourth wave of mergers in the United States. The wave of mergers and acquisition resulting in the consolidation of the US defense industry could very well be considered a fifth wave, as stated by the Chairman of the Federal Reserve, the Honorable Alan Greenspan (Greenspan, 1998, June 16, p.9).

This section provides an overview of the historical trends involving the consolidation of the US defense industry prior to 1990, and then from 1990 to the present. It also includes information on aspects of defense budget and defense policy that precipitated and further encouraged the defense industry consolidation. This discussion is meant to provide broader context for the significance and relevance of this case of event studies.

Industry consolidation often results from available opportunities to improve efficiency when there are too many firms and an abundance of capacity. The surplus of firms and the capacity they maintain often seem to trigger a wave of mergers and acquisitions (Brealey, Meyers & Allen, 2006). What occurred in the US defense industry under such circumstances is not unusual (similar trends occurred in the banking industry), nor should it have been unexpected given the decrease in defense spending after the end of the Cold War.

Figure 1, below, illustrates the defense spending of procurement and research and development (R&D) dollars from FY45 to FY08 to illustrate the funding trend over time compared to the national defense budget, each as a percentage of gross domestic product (GDP).

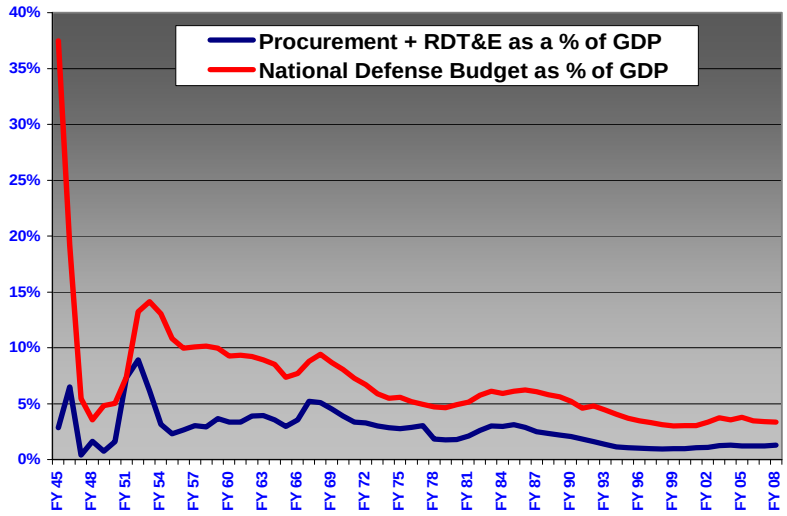

Figure 1. Defense Spending (Trice, 2006, p 13; DoD *Green Book*, 2006)

From 1985 to 1998, there was a 51% decline in the Department of Defense (DoD) R&D and procurement spending. The 10 largest companies in the mid-1980's included McDonnell Douglas, General Dynamics, Rockwell, General Electric, Boeing, Lockheed, United Technologies, Hughes, Raytheon and Grumman. The national defense budget noticeably decreased between 1990 and 2000; this decrease is typically identified as the catalyst for the wave of acquisitions and mergers within the US defense industry. Driessnack and King's assertions counter this position by suggesting factors beyond decreased defense spending on procurement and R&D drove the consolidations: changing institutions and transaction costs (2004). Irrespective of the precise cause, by the end of 2001 the US defense contractor top tier was reduced to five: Boeing, Lockheed Martin, General Dynamics, Raytheon and Northrop Grumman. These five defense firms received the same percentage of DoD prime contracts as the top 10 firms had in 1985 (DoD, 1997-2007, 2003 report). The following explanation of events reveals how this reduction transpired.

In 1992, the US Department of Justice and the Federal Trade Commission jointly issued horizontal merger guidelines, which marked the first time the two federal agencies that share antitrust enforcement jurisdiction had issued joint guidelines. The issuance of this merger guideline document (which was later updated in April of 1997) provided decision-makers the necessary framework for understanding how horizontal mergers and acquisitions (which were much anticipated at this time due to the reduction in defense spending) would be handled. The goal of the guidelines was to describe analytical foundations of merger enforcement and to provide guidance enabling the business community to effectively plan mergers and avoid antitrust problems.

In 1993, a study was published by Price Waterhouse concerning industrial policy in the midst of a watershed of anticipated mergers. This study, commissioned by the Clinton administration, asserted US industrial policy was necessary to ensure the competitiveness of US aerospace and defense firms in the 1990s. Anthony

Velocci summarized the study findings in his article, “Study Urges More Proactive Government Role in Aerospace,” published in *Aviation Week & Space Technology* in April 1993. Some aerospace industry officials expected more supportive policies to emerge regarding the mergers and acquisitions because, ultimately, the DoD was partly responsible for the necessity to merge and consolidate due to its defense budget reductions. The study also indicated companies which were already characterized by a mix of commercial and defense business would be most likely to succeed. In the case of what are now regarded as the aerospace and defense industry’s top five firms, this mix has proven to be the most successful.

A subsequent study was also conducted by the Defense Science Board (DSB), formed as a Task Force on Antitrust Aspects of Defense Industry Consolidation (Velocci, 1993), which sought to advise the DoD on what role it should play in antitrust considerations in the midst of the defense industry mergers and acquisitions. It issued its report in 1994. The DSB study concluded the merger guidelines established in 1992 were sufficient to assess mergers and acquisitions within the defense industry.

The findings of the Price Waterhouse and DSB studies, in conjunction with the defense industry’s increased consolidation activities, prompted a hearing before the Congressional Oversight and Investigations Subcommittee of the Committee on Armed Services in the House of Representatives. This was held on July 27, 1994. The topic of the hearing was the DoD policy on defense industry mergers, acquisitions, and restructuring—which was of extreme interest both to the US government and its defense industry counterparts. Several key principal witnesses at this hearing included David E. Cooper, the Director, Acquisition Policy, Technology, and Competitiveness, US General Accounting Office; the Honorable John M. Deutch, Deputy Secretary of Defense; and Mr. Norman Augustine, Chairman and Chief Executive Officer, Martin-Marietta Corporation.

The hearing largely centered on the impacts of the mergers and acquisitions, what the subsequent firm restructures would cost, and who would pay the lion’s

share of that cost. Mr. Augustine, who appeared on behalf of Martin-Marietta and also seemed to serve as the spokesman for industry, remarked at one point, “under no circumstances does the Government pay any of the costs of any type having to do with the merger or the acquisition itself. That is a shareholder issue, and the shareholder pays those costs, as we believe it should be” (Augustine, 1994, July 27, p. 39).

During this time, and up through 1997, the DoD generally supported the process of the defense industry consolidation because the DoD was acutely aware that restructuring was required to eliminate or reduce the excess capacity and overhead, which translated into higher costs for weapon systems. At the same time, the Pentagon expressed concern as vertical integrations were occurring “as major contractors swallow up their suppliers” (Cole, 1996).

By March of 1998, the General Accounting Office (GAO) published a report confirming this concern titled, *Defense Industry Consolidation: Competitive Effects of Mergers and Acquisitions*, which addressed the issue that perhaps the defense industry consolidations had gone too far—adversely affecting competition in the industry. It speculated that the consolidation could pose future problems unless the DoD took appropriate actions to assess the implications of these mergers and acquisitions. This report and others submitted by the GAO in June, 1998, prompted another Congressional hearing, this time before the Senate Judiciary Committee. The topic this time was mergers and corporate consolidation in the new economy.

At this hearing, the Chairman of the Board of Governors of the Federal Reserve System, the Honorable Alan Greenspan, made some interesting and revelatory comments. In the midst of discussions about the impact of the mergers and acquisitions on the Department of Defense, Mr. Greenspan considered and questioned whether or not there was evidence of benefits to the consumer. He compared the defense industry consolidation to that occurring in the banking industry and suggested the evidence of gained efficiencies and economic gains to the consumer or to the companies themselves was mixed (Greenspan, 1998, p. 11).

This case of event studies covering the mergers and acquisitions of the top five defense firms provides evidence to this effect.

By the end of 2000, the Administration, Congress and the DoD were beginning to seek out actions to support the ability of the US aerospace industry in its efforts to remain robust in the future ("Commission to study relationship," 2000, November 1). A year later, *Aviation Week & Space Technology,* in collaboration with Charles River Associates, undertook a six-month analysis of the US defense industry consolidation that suggested industry was better off after the consolidation but that acknowledged it remained a subject of considerable debate (Velocci, 2001). For the next six years, the mergers and acquisitions continued amidst acknowledgement from some commentators that mergers would significantly reduce competition and drive up prices (Pearlstein, 2005).

Recorded in Chapter IV of this report are the respective merger and acquisition announcements made by each of the top five defense industry contractors: Boeing, Lockheed Martin, General Dynamics, Raytheon and Northrop Grumman. There has continued to be considerable consolidation within the defense industry extending into late 2006. It is also evident that much public and private attention has been paid to these announcements, as well as considerable public debate leading up to them and continuing after the announcements have been made.

The public perception of value in the acquisitions and mergers is reflected best in the market value of the respective firm's securities (i.e., stock value). An appropriate method to quantify whether that change in value is statistically significant is the event study. The following chapter reviews the definition and usefulness of the event study (as found in several research efforts) and elaborates on the methodology used to conduct such a study.

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III. Methodology

A. Selection of Defense Contractors for Study

The selection of the five defense contractors for this case of event studies was based on a collection of trending references from the 1997–2007 *Annual Industrial Capabilities Report to Congress*. In the 2001 report, it reads:

> By the end of 2001, the five largest defense firms received the same percentage of DoD prime contracts as the top ten suppliers received in 1985. Therefore, Lockheed Martin, Boeing, Raytheon, General Dynamics, and Northrop Grumman, the largest five in 2001, are as dominant in the defense market, on a relative basis, as the largest ten in 1985. (DoD, 1997-2007, 2001 report, p. 5)

These five companies maintained dominance throughout the period of this study of the defense mergers—between January 1990 and December 2006. The February 2006 *Annual Defense Capabilities Report to Congress* is the most recent of the series of reports to track the aforementioned five defense contractors as the "top five" in the industry. The individual company profiles supplied by the *Datamonitor*, dated as recent as July 2006, also support this assertion.

This case of event studies is then focused on determining the statistical significance of abnormal stock returns for Lockheed Martin, Boeing, Raytheon, General Dynamics and Northrop Grumman as those returns occur on (or on the day after) the announcement date of each merger/acquisition in which each of the respective top five contractors were involved between January 1990 and June 2006.

B. Event Studies

There is no unique structure to the design of the event studies, but most share a common recipe or general flow of analysis. The purpose of this section is to explain the procedure used in this particular case study. In the disciplines of accounting, economics and financial research, an event study is an analysis to determine if there is a statistically significant reaction in a given financial market to a

particular event that is hypothesized to affect the market value of a public firm. A. Craig MacKinlay, author of "Event Studies in Economics and Finance," asserts:

> The usefulness of such a study comes from the fact that, given rationality in the marketplace, the effects of an event will be reflected immediately in security prices. Thus a measure of the event's economic impact can be constructed using security prices observed over a relatively short period of time. (1997, March, p.13)

Economists assume people act rationally within the marketplace, and that assumption is required for event study analysis; however, the reality is that people within the marketplace *do not* always act rationally. This will become more apparent in the data analysis section of this report. In this case, the researcher used statistical inference to determine if there was a statistically significant abnormal return in the stock value of each of the five major US aerospace and defense contractors, given an announcement of an impending merger or acquisition. In other words, did the announcement of an impending consolidation involving the said company affect its stock price (positively or negatively) in a statistically significant way?

To accomplish this study, the researcher required several pieces of data: announcement dates for the consolidations (defined here as the event), targets of the acquisitions or mergers, the acquiring defense firm's daily stock price data, calculated stock returns and the daily index data for the S&P 500 and its calculated daily returns. The researcher collected announcement dates and announced targets from the Bloomberg database for each of the five contractors (Boeing, Lockheed Martin, General Dynamics, Raytheon and Northrop Grumman). As mentioned previously, these dates were then verified with the respective corporate press releases found on the corporate websites. The event window is typically defined as a larger timeframe than the specific period of interest. In this case, the period of interest is the announcement date itself; the event window is defined as the announcement date plus one trading day after the announcement. Inclusion of the day after the announcement date captures any price effect of announcements

occurring after the stock market closes on the announcement date (MacKinlay, 1997).

Several options for tracing stock and index prices and calculated returns could have been used in these event studies: daily, monthly, quarterly or annually. In examining the frequency of consolidation announcements in conjunction with the desired level of granularity to track the abnormal returns, the researcher determined the daily stock return methodology seemed the most reasonable. The use of daily stock returns is supported in literature surrounding the use of stock returns in event studies (Bowman, 1983; Brown & Warner, 1985; MacKinlay, 1997).

Brown and Warner (1985), in their paper titled, "Using Daily Stock Returns: The Case for Event Studies," examined the properties of daily stock returns and how the particular characteristics of these data affect event study methodologies. They concluded that "daily data generally present few difficulties for event studies" (p. 10). This consideration, coupled with the frequency of consolidation announcements, drove the decision to use the daily stock price data (as opposed to the monthly, quarterly or annual averages) in the construction of these event studies.

In order to determine the impact of the consolidation announcement on the price of a security (i.e., stock price), the abnormal return was measured. The abnormal return is defined as the difference between the actual ex post return of a security over the event window and the normal return (or expected estimated return) of the firm over an event window. The subsequent calculation of the ex post return of a security in this case can either be calculated using arithmetic or logarithmic returns. This case involved both arithmetic and logarithmic returns, respectively, in each of two series of event studies.

The estimation window for the event studies (in calculations involving both the arithmetic and the logarithmic returns) is approximately (and on average) 120 days prior to, but not including, the announcement date. In keeping with common event study methodology, the event date was excluded from the estimation period to

prevent the event from influencing the normal performance estimates (Bowman, 1983; Boehmer, Musumeci & Poulsen, 1991; McKinlay, 1997). The methodology of calculating the abnormal returns based on daily arithmetic and daily logarithmic returns is detailed below.

1. Daily Arithmetic Returns

The daily arithmetic stock returns are simply the percentage change in stock price from day to day. Arithmetic stock returns are calculated by taking the difference between the current day's stock price and the stock price of the day prior and dividing that difference by the stock price of the day prior.

The daily arithmetic index returns represent the percentage change in the value of the index from day to day. Daily arithmetic index returns are calculated by taking the difference between the current day's index value and the index value of the day prior and dividing that difference by the index value of the day prior.

Once the daily arithmetic stock and index returns were calculated, the daily arithmetic stock returns were regressed against the daily arithmetic index returns using the Excel data analysis regression tool. The regression was run for a period of approximately 120 days (six months) prior to the consolidation announcement date, but did not include the announcement date.

Next, the predicted return for the stock price on the announcement date was calculated using the regression equation and the value for the actual index return on that date. The predicted return reveals what the stock return value would have been in the absence of the consolidation announcement based on the historical relationship between the stock and the index. This value becomes the normal return value. An example using a regression run from a Lockheed Martin arithmetic return regression run is provided for illustrative purposes.

On January 8, 1996, Lockheed Martin announced it would acquire Loral Corporation. The daily arithmetic returns are calculated for both the stock price and

the S&P 500 index, and then the daily arithmetic stock returns are regressed against the daily arithmetic index returns using the Excel data analysis regression tool. The following table is supplied as output from the Excel data analysis regression tool.

	Coefficients	*Standard Error*	*t-Stat*	*P-value*
Intercept	0.00099386	0.001050435	0.9461415	0.3459018
Index Return (X-Variable)	0.720999187	0.211131894	3.4149231	0.0008609

Table 2. Lockheed Martin and Loral Arithmetic Return Regression Data

The predicted return is calculated using the regression equation such that

Lockheed Martin predicted stock return =

Y- intercept + X-Variable Coefficient (actual index return on date of announcement)

The coefficient values from Table 2 are substituted into the equation, and the predicted stock value is calculated:

Predicted stock return = .00099386 + .720999187(.002838) = .003040056

where 0.002838 is the previously calculated actual index arithmetic return on the date of the consolidation announcement.

However, in order to determine the impact of the consolidation announcement on the stock price, the abnormal return must be measured. The abnormal return is calculated by subtracting the predicted stock price return from the actual stock price arithmetic return on a given day. In this case, it was calculated for the day of the announcement and five trading days thereafter, though the event itself is considered the announcement date and the day after the announcement.

Again, a table is provided from the Lockheed Martin and Loral regression data for illustrative purposes. The abnormal returns are calculated and listed in the far right column of Table 3. The value highlighted in blue was previously calculated.

Date of Stock Price	Stock Price	Daily Arith. Stock Ret	Value of Index	Daily Arith Index Ret	Abnormal Returns
1/8/1996	40.125	0.0371567	618.46	0.002837638	0.03411691
1/9/1996	39.4375	-0.017134	609.45	-0.014568444	-0.00762398

Table 3. Lockheed Martin and Loral Arithmetic Return Abnormal Return

The abnormal return is then divided by the standard error of the regression to supply the test statistic required for the data analysis. The standard error is also an Excel output which is automatically generated by the data analysis regression tool.

Regression Statistics	
Multiple R	0.292117464
R Square	0.085332613
Adjusted R Square	0.078015274
Standard Error	***0.011660913***
Observations	127

Table 4. Lockheed Martin and Loral Standard Error (Arithmetic Return Regression)

To complete this example, the test statistic (or t-stat) is calculated for January 8, 1996, by dividing the abnormal return (.03411691) by the standard error highlighted in Table 4 (.011660913)—resulting in a *t*-stat value of 2.9257 (rounded).

2. Daily Logarithmic Returns

The daily logarithmic stock returns are calculated by dividing the natural logarithm after the current day's stock price by the stock price one day prior. The daily index logarithmic returns are calculated by dividing the natural logarithm after the current day's index value by the index value of the previous day.

Once the daily logarithmic stock and index returns are calculated, the daily logarithmic stock returns are regressed against the daily logarithmic index returns using the Excel data analysis regression tool. The regression is run for a period of

approximately 120 days (six months) prior to the consolidation announcement date, but does not include the announcement date.

Next, the predicted return for the stock price on the announcement date is calculated using the regression equation and the value for the actual index return on that date. The predicted return reveals what the stock return would have been in the absence of the consolidation announcement, based on the historical relationship between the stock and the index. This value becomes the normal return value. An example using a regression run from a Lockheed Martin logarithmic returns regression run is provided for illustrative purposes.

On January 8, 1996, Lockheed Martin announced it would acquire Loral Corporation. The daily logarithmic returns are calculated for both the stock price and the S&P 500 index value, and then the daily logarithmic stock returns are regressed against the daily logarithmic index returns. The following table (Table 5) is supplied as output from the Excel data analysis regression tool.

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.001072493	0.001039628	1.031612	0.304246
Index Return (X-Variable)	0.739308864	0.209018417	3.537051	0.000569

Table 5. Lockheed Martin and Loral Logarithmic Return Regression Data

The predicted return is calculated using the regression equation such that:

Lockheed Martin predicted stock return =

Y- intercept + X-Variable Coefficient (actual index return on date of announcement)

The coefficient values from Table 5 are substituted into the equation, and the predicted stock value is calculated:

Predicted stock return = .001072493 + .739308864(.00283362) = .003167413

The value 0.002833362 is the previously calculated actual index arithmetic return on the date of the consolidation announcement. However, in order to determine the impact of the consolidation announcement on the stock price, the abnormal return must be measured. The abnormal return is calculated by subtracting the predicted stock price return from the actual stock price arithmetic return on a given day. In this case, it is calculated for the day of the announcement and five trading days thereafter.

Again, a table is provided from the Lockheed Martin and Loral regression data for illustrative purposes. The abnormal returns have been calculated and are listed in the far right column of Table 6.

Date of Stock Price	Stock Price	Daily Log. Stock Ret	Value of Index	Daily Logarithmic Index Ret	Abnormal Returns
1/8/1996	40.125	0.036483	618.46	0.00283362	0.033315618
1/9/1996	39.4375	-0.01728	609.45	-0.014675606	-0.007505129

Table 6. Lockheed Martin and Loral Logarithmic Return Abnormal Return

The abnormal return (highlighted in blue in Table 6) is then divided by the standard error of the regression to supply the test statistic required for the data analysis.

The standard error is also an Excel output, which is automatically generated by the data analysis regression tool.

Regression Statistics	
Multiple R	0.301628978
R Square	0.09098004
Adjusted R Square	0.083707881
Standard Error	***0.011545906***
Observations	127

Table 7. Lockheed Martin and Loral Standard Error (Log. Return Regression)

To complete this example, the test statistic (or *t*-stat) would be calculated for January 8, 1996, by dividing the abnormal return (.033315618) by the standard error highlighted in Table 7 (.011545906) and resulting in a *t*-stat value of 2.8855 (rounded).

C. Method of Analysis

The method of analysis for this case of event studies is a two-tailed hypothesis test using the test statistic calculated from data generated by the event studies to determine whether to accept or reject the null hypothesis.

1. Hypotheses Defined

The null hypothesis, denoted as H_o, is defined as the consolidation announcement having no effect on the abnormal return of a given stock price. In other words, the null hypothesis is the abnormal return would be equal to zero. The alternative hypothesis, denoted as H_1, is defined as the consolidation announcement having an effect on the abnormal return of a given stock price. In other words, the abnormal returns are not equal to zero. This would mean the consolidation announcement *had* an effect on the abnormal return of the stock price.

Mathematically, the hypotheses are represented as follows:

H_o: $\beta_1 = 0$, where β_1 represents the abnormal return

H_1: $\beta_1 \neq 0$, where β_1 represents the abnormal return

2. Determination of Statistical Significance

If the abnormal returns calculated for a given date are not equal to zero, it is requisite to use the test statistic calculated from the data (as outlined previously in Section B) to determine whether or not there is sufficient evidence to infer statistical significance in the finding. The calculated *t*-statistic is compared to the statistics table commonly titled, "Critical Values of *t*." A subsection of this table is pasted below in Table 8, and is supplied from M. Merrington (as cited in Keller, 2005).

Deg. Frdm	$t_{.100}$	$t_{.050}$	$t_{.025}$	$t_{.010}$	$t_{.005}$
120	1.289	1.658	1.980	2.358	2.617

Table 8. Critical Values of *t*

The degrees of freedom used to interpret the *t*-statistic are defined as the number of observations, *n*, minus the number of regressors in the sample. In this case, the number of observations, *n*, represents the number of trading days used in the regression (average 120 days +/- 1 day). There is one regressor, so the degrees of freedom are equal to the number of trading days minus one. The table lists critical values of *t* for 120 and then 140 degrees of freedom. In this case, the degrees of freedom used to determine the critical *t* value threshold is 120, since that is the closest value in the table that matches the actual degrees of freedom from the event studies.

The *t*-statistic thresholds used to determine the level of statistical significance of the abnormal return are listed below in Table 9 and are based on the critical values of *t* listed in the above table.

Range	t <1.289	1.289<t<1.658	1.658<t<1.980	1.980<t<2.358	2.358<t<2.617	t>2.617
Level of Stat Sig	**< 10% none**	**10% weak**	**5% moderate**	**2.5% strong**	**1% very strong**	**.05% very strong**

Table 9. *t*-Statistic Thresholds

For example, if the *t*-statistic is lower than the critical value of *t* at 1.289, then the finding is not significant, and the null hypothesis (the abnormal return actually equals zero) is accepted. It is then probable that the abnormal return reflected happened by chance. If the *t*-statistic is greater than the critical value for *t* of 1.289 but is less than 1.658, then the finding is significant at the 10% level, and the inference is of weak statistical significance. Even so, the finding is considered significant enough to reject the null hypothesis and accept the alternative hypothesis—thereby concluding the abnormal return is not equal to zero; the consolidation announcement affected the stock price return, and the probability is small that this abnormal return happened by chance. Of course, the stronger the

statistical significance, the smaller the probability that the abnormal return happened by chance.

The *t*-statistic is calculated for each of the 250 regression runs involving both the arithmetic and the logarithmic returns used to calculate the abnormal returns. Several of these data calculations (106 in total) were run again in the robustness checks of the arithmetic and logarithmic returns, which is detailed in the next subsection.

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IV. Data Analysis

A. Overview

The purpose of this section is to present the findings of the 250 event studies for the top five US defense contractors. Each data set contains the results of the event studies and is presented first in terms of the arithmetic returns, and then in terms of the logarithmic returns. Each company's events are presented in depth individually; however, in the way of an overview, the following table represents composite percentages of those abnormal returns found to be statically significant across all 125 of the arithmetic return events and then across all 125 of the logarithmic return events. Both positive and negative statistically significant results are included.

Contractor	Percentage of Events Experiencing Statistically Significant Abnormal Returns	Percentage of Events Experiencing Positive Statistically Significant Abnormal Returns	Percentage of Events Experiencing Negative Statistically Significant Abnormal Returns
Boeing	**31.6%**	**16.7%**	**83.3%**
Lockheed Martin	**40.0%**	**40.0%**	**60.0%**
General Dynamics	**27.8%**	**80.0%**	**20.0%**
Raytheon	**44.4%**	**37.5%**	**62.5%**
Northrop Grumman	**66.7%**	**22.2%**	**77.8%**

Table 10. Summary of Arithmetic Return % of Statistically Significant Events

For the entire set of 125 regression runs across each of the five contractors' announcement dates (using the arithmetic returns calculation as the baseline), only 42% result in statistically significant abnormal returns either on or one day after the announcement date. As noted in Table 10, two contractor results are higher than the overall average. Raytheon's announcements concerning its plans to consolidate resulted in statistically significant abnormal returns 44% of the time, and Northrop Grumman's announcements concerning its plans to consolidate resulted in

statistically significant abnormal returns 67% of the time. Lockheed, Boeing and General Dynamics' frequency of occurrence of statistically significant abnormal returns fell at or below 40% when the researcher used the arithmetic return to calculate the abnormal returns.

On average, 40% of the events experiencing statistically significant abnormal returns based on the arithmetic return are positive, while 60% are negative statistically significant abnormal returns. Boeing, Lockheed Martin, Raytheon and Northrop Grumman maintained statistically significant abnormal returns that followed this pattern (more were negative than positive). In the case of Boeing, the statistically significant abnormal returns were overwhelmingly negative 83% of the time; likewise, for Northrop Grumman, the statistically significant abnormal returns were overwhelmingly negative 78% of the time. However, 80% of General Dynamics' statistically significant abnormal returns were positive, and 20% were negative. This suggests, in the case of General Dynamics, the market perception was much more positive in response to the company consolidation announcements.

Overall, the results using the arithmetic return calculations suggest the announcement of an impending consolidation did not always result in a statistically significant abnormal return on the stock price of the respective defense contractor. The results also suggest that when there is a statistically significant abnormal return, the returns are more likely to decrease than increase (in four out of five of the top defense contractors).

The results using the logarithmic returns reflected a similar overall percentage of events experiencing statistically significant abnormal returns: 41%. The percentage of positive and negative statistically significant abnormal returns is also consistent with the overall results using the arithmetic returns. Overall, using the logarithmic returns, 39% of the events experiencing statistically significant abnormal returns experienced increases in those returns (positive abnormal returns), while 61% of the events experiencing statistically significant abnormal returns experienced

decreases in those returns (negative abnormal returns). Table 11 lists the overall results using the logarithmic returns to calculate the abnormal returns.

Contractor	Percentage of Events Experiencing Statistically Significant Abnormal Returns	Percentage of Events Experiencing Positive Statistically Significant Abnormal Returns	Percentage of Events Experiencing Negative Statistically Significant Abnormal Returns
Boeing	**26.3%**	**20.0%**	**80.0%**
Lockheed Martin	**47.8%**	**45.5%**	**54.5%**
General Dynamics	**30.6%**	**63.6%**	**36.4%**
Raytheon	**44.4%**	**37.5%**	**62.5%**
Northrop Grumman	**59.3%**	**18.8%**	**81.2%**

Table 11. Summary of Logarithmic Return % of Statistically Significant Events

This data appears to suggest that using the logarithmic returns to determine statistically significant abnormal returns will yield the same overall percentage of positive and negative results. However, when examining the statistically significant results as broken down by contractor, the researcher found three (Boeing, Lockheed Martin and Raytheon) out of five contractor's announcement events resulted in a greater percentage of occurrence of positive statistically significant abnormal returns and lower negative statistically significant returns. General Dynamics and Northrop Grumman's announcement events resulted in a lower percentage of occurrence of positive statistically significant abnormal returns and a higher percentage of negative statistically significant abnormal returns. This suggests that although the aggregate arithmetic and logarithmic returns percentages of events experiencing positive statistically significant abnormal returns are the same, the results tend to vary by contractor. Thus, the logarithmic and arithmetic returns produce slightly different results.

B. Boeing Company

Boeing made 19 announcements between 1990 and 2006 concerning its consolidation plans with other companies.

These event dates and the calculated *t*-statistic for the abnormal returns generated using the arithmetic return on the announcement date (and one day after the announcement) are presented in Table 12. For ease of presentation and reading, the statistical significance of a *t*-statistic (*t*-stat) is only noted if it was at least significant at the 10% level. Blank spaces in the Stat Sig columns in Table 12 and subsequent tables included in the data analysis chapter represent statistically insignificant findings.

Announce Date	Target	t-Stat	Stat Sig	t-stat day after	Stat Sig
8/1/1996	Rockwell International Corp.	-0.9645		0.2125	
12/16/1996	**McDonnell Douglas Corp**	**4.4298**	**1%**	**-0.3802**	
2/8/1999	Advanced Visual Software	-0.9250		-0.08346	
7/2/1999	Radiant Energy Corp.	-0.2270		-0.7121	
1/13/2000	**Hughes Satellite Systems**	**-1.0961**		**1.692**	**5%**
6/1/2000	Autometric, Inc.	0.7898		-0.6595	
6/27/2000	SVS, Inc.	0.2793		0.4455	
8/2/2000	Continental Graphics Corp.	0.8954		-0.8291	
8/15/2000	**Jeppesen Sanderson, Inc.**	**-1.8254**	**5%**	**-0.9324**	
9/1/2000	AeroInfo Systems, Inc.	0.7164		0.5178	
10/17/2000	Hawker De Havilland Ltd.	0.3972		0.1101	
7/27/2001	SBS International	-0.08792		0.647	
9/23/2002	**Flight Safety Boeing Training**	**-1.7590**	**5%**	**1.657**	**5%**
1/10/2003	Conquest, Inc.	-0.00047		0.7131	
5/4/2004	Frontier Systems, Inc.	-0.8517		0.7874	
9/29/2004	**MBDA**	**-3.2955**	**1%**	**1.009**	
3/3/2006	Carmen Systems AB	-0.07311		-0.09483	
5/1/2006	Aviall, Inc.	-0.0848		-0.05505	
8/18/2006	**C-Map**	**-1.4202**	**10%**	**-0.6854**	

Table 12. Boeing Arithmetic Return Events: Statistical Significance

In the case of Boeing, 32% of the announcements resulted in statistically significant abnormal returns when the researcher used the arithmetic returns as the basis for calculating the abnormal return. Of these statistically significant abnormal returns experienced by Boeing, 17% were positive, and 83% were negative.

When the researcher utilized the logarithmic returns as the basis for calculating the abnormal return, one less event experienced a statistically significant abnormal return (Boeing Flight Safety); this altered the percentages of events experiencing positive or negative statistically significant abnormal returns. Table 13 contains the *t*-statistics and levels of statistical significance for each event using the logarithmic returns.

Announce Date	*Target*	t-Stat	Stat Sig	t-stat day after	Stat sig
8/1/1996	Rockwell International Corp.	-0.9457		0.221	
12/16/1996	**McDonnell Douglas Corp**	**4.3529**	**0.05%**	**-0.3767**	
2/8/1999	Advanced Visual Software	-0.9027		-0.05679	
7/2/1999	Radiant Energy Corp.	-0.2197		-0.7168	
1/13/2000	**Hughes Satellite Systems**	**-1.1205**		**1.728**	**5%**
6/1/2000	Autometric, Inc.	0.7935		-0.6522	
6/27/2000	SVS Inc	0.2936		0.458	
8/2/2000	Continental Graphics Corp	0.9019		-0.8298	
8/15/2000	**Jeppesen Sanderson, Inc.**	**-1.8603**	**5%**	**-0.9315**	
9/1/2000	AeroInfo Systems, Inc.	0.7247		0.5323	
10/17/2000	Hawker De Havilland Ltd.	0.4158		0.1239	
7/27/2001	SBS International	-0.0793		0.6401	
9/23/2002	Flight Safety Boeing Training	-0.9371		0.06851	
1/10/2003	Conquest, Inc.	-0.0304		0.7075	
5/4/2004	Frontier Systems, Inc.	-0.8491		0.7887	
9/29/2004	**MBDA**	**-3.3305**	**0.05%**	**1.011**	
3/3/2006	Carmen Systems AB	0.0274		-0.03462	
5/1/2006	Aviall, Inc.	0.0704		-0.04142	
8/18/2006	**C-Map**	**-1.4296**	**10%**	**-0.6886**	

Table 13. Boeing Logarithmic Return Events: Statistical Significance

Because there was one less statistically significant abnormal return, the percentages changed: 20% of events experienced positive statistically significant abnormal returns, and 80% of events experienced negative statistically significant abnormal returns.

These results from both the arithmetic and logarithmic returns suggest Boeing's announcements concerning its consolidation plans with other companies do not always result in statistically significant abnormal returns to its stock price; however, when the abnormal returns are statistically significant, those abnormal returns are overwhelmingly negative. The large percentage of negative statistically significant abnormal returns using the arithmetic returns suggests the market perception of the announced consolidations is also negative.

C. Lockheed Martin

Lockheed made two announcements prior to becoming Lockheed Martin; subsequently, Lockheed Martin made 23 subsequent announcements concerning its consolidation plans with other companies—for a total of 25 announcements between January 1990 and December 2006, as shown in Table 14.

These event dates and the calculated *t*-statistic for the abnormal returns generated using the arithmetic return on the announcement date (and one day after the announcement) are presented in Table 14. For ease of presentation and reading, the statistical significance of a *t*-statistic (*t*-stat) is only noted if it was at least significant at the 10% level. Blank spaces in the Stat Sig columns represent statistically insignificant findings.

Announce Date	*Target*	t-Stat	Stat Sig	t-stat day after	Stat sig
12/9/1992	**Tactical Military Aircraft**	**6.0648**	**0.05%**	**-1.1845**	
8/30/1994	**Martin Marietta**	**17.3116**	**0.05%**	**2.9637**	**0.05%**
1/8/1996	**Loral Corp.**	**2.9257**	**0.05%**	**-0.6538**	
7/3/1997	**Northrop Grumman Corp.**	**-4.3990**	**0.05%**	**0.6553**	
2/26/1998	**Postal Technologies**	**1.5769**	**10%**	**0.09458**	
12/14/1998	**US Public Technologies LLC**	**0.7966**		**-1.913**	**10%**
1/8/1999	Canadian Public Technologies	0.0782		0.3874	
9/20/1999	**Comsat Corp.**	**-3.2440**	**0.05%**	**0.2853**	
10/26/2001	Oao Corp.	0.8217		-0.9259	
3/11/2003	LongShot Wing Kit	-0.9844		0.4737	
5/15/2003	ORINCON Industries	-0.3720		-0.3486	
8/1/2003	Federal Govt IT Business	-0.6233		0.1312	
9/15/2003	**Titan Corp**	**-0.0888**		**-1.763**	**5%**
10/29/2003	Astrolink International LLC	-0.8921		0.3452	
10/29/2004	Sippican, Inc.	-0.1282		1.171	
12/13/2004	**STASYS Ltd.**	**0.8606**		**-1.531**	**10%**
2/18/2005	Sytex Group, Inc.	-0.2419		0.0903	
8/16/2005	INSYS Group Ltd.	0.7317		0.7123	
9/8/2005	Coherent Technologies, Inc.	-0.0151		-0.5666	
12/16/2005	**Aspen Systems Corp**	**0.4200**		**-1.636**	**10%**
1/23/2006	HMT Vehicles Ltd.	0.7642		0.2962	
5/4/2006	Savi Technology, Inc.	-0.8335		0.0945	
6/12/2006	ISX Corp	-1.1303		-0.1453	
8/17/2006	Pacific Architects and Engineers	-0.6353		-0.4793	
12/21/2006	Management Systems Designer	0.4846		-0.0601	

Table 14. Lockheed Martin Arithmetic Return Events: Statistical Significance

In the case of Lockheed Martin, 40% of the announcements resulted in statistically significant abnormal returns when the researcher used the arithmetic returns as the basis for calculating the abnormal return. Of these statistically significant abnormal returns experienced by Lockheed Martin, 40% were positive, and 60% were negative.

When using the logarithmic returns as the basis for calculating the abnormal return, the researcher found one more event which experiences a statistically significant abnormal return (Astrolink International LLC), and this altered the percentages of events experiencing positive or negative statistically significant abnormal returns. Table 15 contains the *t*-statistics and levels of statistical significance for each event using the logarithmic returns. Because there was one more statistically significant abnormal return, the percentages changed: 46% of events experienced positive statistically significant abnormal returns, and 54% of events experienced negative statistically significant abnormal returns.

Announce Date	*Target*	t-Stat	Stat Sig	t-stat day after	Stat sig
12/9/1992	**Tactical Military Aircraft**	**5.8893**	**0.05%**	**-1.1901**	
8/30/1994	**Martin Marietta**	**15.9493**	**0.05%**	**2.8767**	**0.05%**
1/8/1996	**Loral Corp.**	**2.8855**	**0.05%**	**0.6500**	
7/3/1997	**Northrop Grumman Corp.**	**-4.4377**	**0.05%**	**0.6759**	
2/26/1998	**Postal Technologies**	**1.5729**	**10%**	**0.09832**	
12/14/1998	**US Public Technologies LLC**	**0.8137**		**-1.932**	**5%**
1/8/1999	Canadian Public Technologies	0.0858		0.3903	
9/20/1999	**Comsat Corp.**	**-3.3134**	**0.05%**	**0.2892**	
10/26/2001	Oao Corp.	0.8467		-0.9363	
3/11/2003	LongShot Wing Kit	-0.9830		0.4852	
5/15/2003	ORINCON Industries	-0.0852		-0.2885	
8/1/2003	Federal Govt IT business	-0.6290		0.1394	
9/15/2003	**Titan Corp**	**-0.0853**		**-1.769**	**5%**
10/29/2003	**Astrolink International LLC**	**2.5396**	**1%**	**0.122**	
10/29/2004	Sippican, Inc.	-0.1267		1.144	
12/13/2004	**STASYS Ltd.**	**0.8558**		**-1.533**	**10%**
2/18/2005	The Sytex Group, Inc.	-0.2359		0.1002	
8/16/2005	INSYS Group Ltd.	0.7380		0.7042	
9/8/2005	Coherent Technologies, Inc.	-0.0083		-0.654	
12/16/2005	**Aspen Systems Corp**	**0.4281**		**-1.659**	**5%**
1/23/2006	HMT Vehicles Ltd.	0.7662		0.3004	
5/4/2006	Savi Technology, Inc.	-0.8278		0.11	
6/12/2006	ISX Corp	-1.1379		-0.1395	
8/17/2006	Pacific Architects and Engineers	-0.6278		0.4693	
12/21/2006	Management Systems Designer	0.4922		-0.05451	

Table 15. Lockheed Martin Logarithmic Return Events: Statistical Significance

These results from both the arithmetic and logarithmic returns suggest Lockheed Martin's announcements concerning its consolidation plans with other companies do not always result in statistically significant abnormal returns to its stock price; however, when the abnormal returns are statistically significant, those

abnormal returns are negative. The close percentage of positive and negative statistically significant abnormal returns using the arithmetic returns and the logarithmic returns suggests the market perception of the announced consolidations is close to a 50-50 split.

D. General Dynamics

General Dynamics made a total of 36 consolidation announcements between January 1990 and December 2006 concerning its consolidation plans with other companies, as shown in Tables 16 and 17.

These event dates and the calculated *t*-statistic for the abnormal returns generated using the arithmetic return on the announcement date (and one day after the announcement) are presented in Table 16. For ease of presentation and reading, the statistical significance of a *t*-statistic (*t*-stat) is only noted if it was at least significant at the 10% level. Blank spaces in the Stat Sig columns represent statistically insignificant findings.

In the case of General Dynamics, only 28% of the announcements resulted in statistically significant abnormal returns when the researcher used the arithmetic returns as the basis for calculating the abnormal return. Of these statistically significant abnormal returns experienced by General Dynamics, 80% were positive, and 20% were negative. Of the five sets of US defense contractor data used in this case, General Dynamics was the only one to experience an overwhelming percentage of events experiencing positive statistically significant abnormal returns.

When using the logarithmic returns as the basis for calculating the abnormal return, the researcher found one more event which experienced a statistically significant abnormal return (NASSCO Holdings, Inc.), and this altered the percentages of events experiencing positive or negative statistically significant abnormal returns. Table 17 contains the *t*-statistics and levels of statistical significance for each event using the logarithmic returns.

Announce Date	*Target*	t-Stat	Stat Sig	t-stat day after	Stat Sig
8/17/1995	**Bath Iron Works Corp.**	**6.1569**	**0.05%**	**-0.9329**	
8/21/1997	Advanced Technology Systems	-0.8578		0.3862	
11/3/1997	Computing Devices International	0.3394		0.1954	
9/4/1998	Caldwell's Diving Co.	-0.9856		1.2470	
10/8/1998	NASSCO Holdings, Inc.	0.0285		-1.2397	
2/18/1999	Newport News Shipbuilding I	1.2592		0.1979	
5/17/1999	**Gulfstream Aerospace Corp.**	**-3.8420**	**0.05%**	**0.2172**	
6/22/1999	**GTE Gvt Syst**	**-0.0684**		**1.7590**	**5%**
4/13/2000	ENSB	0.8070		0.3709	
5/12/2000	Saco Defense Corp.	-0.0564		0.2414	
9/12/2000	Matthews Land Co., Inc.	-0.3090		-0.4684	
10/30/2000	**Devcor, Inc.**	**1.8439**	**5%**	**1.2900**	**10%**
11/9/2000	Primex Technologies, Inc.	0.4955		-0.3010	
11/16/2000	Creative Concepts Corp.	-0.1521		0.1428	
4/25/2001	**Newport News Shipbuilding I**	**-0.9193**		**1.7920**	**5%**
5/1/2001	Galaxy Aerospace Co LP	0.2938		0.7137	
8/6/2001	Motorola Integrated Information	-0.8013		0.8217	
5/2/2002	Advanced Technical Products	0.4565		0.0227	
8/27/2002	Command System, Inc.	0.8156		-0.4443	
10/31/2002	EWK Eisenwerke Kaiserslaute	0.1328		0.0890	
12/19/2002	General Motors Defense	0.9864		-0.3219	
3/31/2003	Creative Technologies, Inc.	-0.9308		0.3937	
6/9/2003	**Veridian Corp/United States**	**-0.9856**		**1.4270**	**10%**
7/25/2003	Intercontinental Manufacturing Co.	0.2533		0.1661	
7/30/2003	Digital System Resources, Inc.	-0.1491		0.5886	
9/30/2003	SSF-Holding GmbH	0.4388		1.0300	
3/11/2004	**Alvis Plc**	**-0.9838**		**1.5910**	**10%**
3/18/2004	**Spectrum Astro, Inc.**	**1.0904**		**-1.6600**	**5%**
6/9/2004	TriPoint Global Comm.	0.2076		0.3463	
4/1/2005	MAYA Viz Ltd.	0.5417		0.1298	
8/3/2005	Itronix Corp.	0.0910		-0.3888	
8/16/2005	Tadpole Computer, Inc.	-0.8786		0.5426	
12/13/2005	**FC Business Systems, Inc.**	**1.3091**	**10%**	**-0.4217**	
12/14/2005	**Anteon International Corp.**	**-0.4258**		**2.4500**	**1%**
2/23/2006	SNC Technologies, Inc.	0.7593		0.5959	
5/17/2006	Chamberlain Manufacturing Corp.	-0.4812		0.1556	

Table 16. General Dynamics Arithmetic Return Events: Statistical Significance

Announce Date	*Target*	t-Stat	Stat Sig	t-stat day after	Stat sig
8/17/1995	**Bath Iron Works Corp.**	**5.9748**	**0.05%**	**-0.9308**	
8/21/1997	Advanced Technology Systems	-0.8548		0.3908	
11/3/1997	Computing Devices International Unit	0.3463		0.2042	
9/4/1998	Caldwell's Diving Co.	-0.6871		0.8608	
10/8/1998	**NASSCO Holdings, Inc.**	**0.0285**		**-2.5860**	**1%**
2/18/1999	Newport News Shipbuilding I	1.2510		0.2093	
5/17/1999	**Gulfstream Aerospace Corp/D**	**-4.0112**	**0.05%**	**0.2247**	
6/22/1999	**GTE Government Systems**	**-0.0590**		**1.7340**	**5%**
4/13/2000	ENSB	0.8116		0.3786	
5/12/2000	Saco Defense Corp.	-0.0446		0.2552	
9/12/2000	Matthews Landing Co., Inc.	-0.2776		-0.4537	
10/30/2000	**Devcor, Inc.**	**1.8349**	**5%**	**1.2940**	**10%**
11/9/2000	Primex Technologies, Inc.	0.5043		-0.2032	
11/16/2000	Creative Concepts Corp.	-0.1428		0.1531	
4/25/2001	**Newport News Shipbuilding I**	**-0.9192**		**1.7710**	**5%**
5/1/2001	Galaxy Aerospace Co LP	0.3037		0.7196	
8/6/2001	Motorola Integrated Information	-0.7979		0.8211	
5/2/2002	Advanced Technical Products	0.4565		0.0133	
8/27/2002	Command System, Inc.	0.8149		-0.4293	
10/31/2002	EWK Eisenwerke Kaiserslaute	0.1432		0.0994	
12/19/2002	General Motors Defense	0.9786		-0.3087	
3/31/2003	Creative Technologies, Inc.	-0.9146		0.3945	
6/9/2003	**Veridian Corp/United States**	**-0.9715**		**1.3900**	**10%**
7/25/2003	Intercontinental Manufacturing Company	0.2640		0.1750	
7/30/2003	Digital System Resources, Inc.	-0.1399		0.5981	
9/30/2003	SSF-Holding GmbH	0.4462		1.0310	
3/11/2004	**Alvis Plc**	**-0.9834**		**1.5840**	**10%**
3/18/2004	**Spectrum Astro, Inc.**	**1.0905**		**-1.6700**	**5%**
6/9/2004	TriPoint Global Communications	0.2149		0.3507	
4/1/2005	MAYA Viz Ltd.	0.5467		0.1356	
8/3/2005	Itronix Corp.	0.0969		-0.3862	
8/16/2005	Tadpole Computer, Inc.	-0.8797		0.5483	
12/13/2005	**FC Business Systems, Inc.**	**1.3066**	**10%**	**-0.4294**	
12/14/2005	**Anteon International Corp.**	**-0.4235**		**2.4330**	**1%**
2/23/2006	SNC Technologies, Inc.	0.7625		0.6009	
5/17/2006	Chamberlain Manufacturing Corp.	-0.3318		0.1291	

Table 17. General Dynamics Logarithmic Return Events: Statistical Significance

Because there was one more statistically significant abnormal return, the percentages changed: 64% of events experienced positive statistically significant

abnormal returns, and 36% of events experienced negative statistically significant abnormal returns.

These results from both the arithmetic and logarithmic returns suggest General Dynamics' announcements concerning its consolidation plans with other companies did not always result in statistically significant abnormal returns to its stock price; however, when the abnormal returns were statistically significant, those abnormal returns were overwhelmingly positive when using the arithmetic returns. The close, high percentage of positive and statistically significant abnormal returns using the arithmetic returns suggests the market perception of the announced consolidations was positive. Interestingly, in the case of General Dynamics, the logarithmic returns results suggest the market perception was not as strongly positive.

E. Raytheon

Raytheon made a total of 18 consolidation announcements between January 1990 and December 2006 concerning its consolidation plans with other companies, as shown in Tables 18 and 19. Note: there are two date references for Defense Business. These announcements regarding Raytheon's acquisition of Defense Business were documented on each of the two dates. Only the second announcement showed any statistically significant abnormal returns.

These event dates and the calculated *t*-statistic for the abnormal returns generated using the arithmetic return on the announcement date (and one day after the announcement) are presented in Table 18. For ease of presentation and reading, the statistical significance of a *t*-statistic (*t*-stat) is only noted if it was at least significant at the 10% level. Blank spaces in the Stat Sig columns represent statistically insignificant findings.

In the case of Raytheon, 44% of the announcements resulted in statistically significant abnormal returns when using the arithmetic returns as the basis for

calculating the abnormal return. Of these statistically significant abnormal returns experienced by Raytheon, 38% were positive and 62% were negative.

Announce Date	*Target*	t-Stat	Stat Sig	t-stat day after	Stat sig
1/20/1993	**Applied Remote Technology**	**-1.3347**	**10%**	**1.531**	**10%**
2/17/1993	**Power Group & Transportation**	**-0.3420**		**-2.843**	**0.05%**
6/1/1993	**Corporate Jets Business**	**1.0605**		**1.473**	**10%**
11/17/1993	**Ebasco Services, Inc.**	**-0.0217**		**2.548**	**0.05%**
9/9/1994	**Xyplex, Inc.**	**-0.3750**		**-2.516**	**0.05%**
4/3/1995	**Raytheon E-Systems, Inc.**	**-2.1226**	**2.5%**	**-2.557**	**0.05%**
6/30/1995	Litwin Engineers & Construction	-0.4432		0.4744	
4/8/1996	2 Chrysler Technologies Business	-1.0318		0.293	
1/6/1997	Defense business	0.3720		-0.833	
1/16/1997	**Defense Business**	**1.7945**	**5%**	**-0.06199**	
7/21/1998	Communication System Business	-1.2441		1.229	
12/20/2002	Solipsys Corp.	0.0594		0.8501	
12/20/2002	JPS Communications, Inc.	0.0594		0.8501	
7/25/2003	Aerospace and Defense Services	-0.9681		-0.6129	
10/6/2004	**Photon Research Associates**	**-1.7646**	**5%**	**-0.9233**	
8/22/2005	UTD, Inc.	-0.5218		0.5187	
12/29/2005	Flight Options LLC	-0.5718		1.142	
7/5/2006	Virtual Technology Corp.	-0.0705		-0.0909	

Table 18. Raytheon Arithmetic Return Events: Statistical Significance

When the researcher used the logarithmic returns as the basis for calculating the abnormal return, exactly the same percentage of events experienced statistically significant abnormal returns as when she used the arithmetic returns. Table 19 contains the *t*-statistics and levels of statistical significance for each event using the logarithmic returns. Again, 44% of the announcements resulted in statistically significant abnormal returns when using the logarithmic returns as the basis for

calculating the abnormal return. Of these statistically significant abnormal returns experienced by Raytheon, 38% were positive, and 62% were negative.

These results from both the arithmetic and logarithmic returns suggest Raytheon's announcements concerning its consolidation plans with other companies did not always result in statistically significant abnormal returns to its stock price; however, when the abnormal returns were statistically significant, those abnormal returns were usually negative when the researcher used either the arithmetic or the logarithmic returns.

Announce Date	*Target*	t-Stat	Stat Sig	t-stat day after	Stat sig
1/20/1993	**Applied Remote Technology**	**-1.3443**	**10%**	**1.518**	**10%**
2/17/1993	**Power Group & Transportation**	**-0.3723**		**-2.986**	**0.05%**
6/1/1993	**Corporate Jets Business**	**0.4418**		**1.457**	**10%**
11/17/1993	**Ebasco Services, Inc.**	**0.2962**		**2.536**	**1%**
9/9/1994	**Xyplex, Inc.**	**-0.3744**		**-2.191**	**1%**
4/3/1995	**Raytheon E-Systems, Inc.**	**-2.1368**	**2.5%**	**-2.575**	**1%**
6/30/1995	Litwin Engineers & Construction	-0.4414		0.4783	
4/8/1996	2 Chrysler Technologies Business	-1.0362		0.3021	
1/6/1997	Defense Business	0.3767		-0.8176	
1/16/1997	**Defense Business**	**1.7598**	**5%**	**-0.03469**	
7/21/1998	Communication System Business	-1.2749		1.236	
12/20/2002	Solipsys Corp.	0.0754		0.852	
12/20/2002	JPS Communications, Inc.	0.0754		0.852	
7/25/2003	Aerospace and Defense Services	-0.7630		-0.6137	
10/6/2004	**Photon Research Associates**	**-1.7673**	**5%**	**-0.9225**	
8/22/2005	UTD, Inc.	-0.5310		0.5146	
12/29/2005	Flight Options LLC	-0.5739		1.149	
7/5/2006	Virtual Technology Corp.	-0.0081		-0.0348	

Table 19. Raytheon Logarithmic Return Events: Statistical Significance

The results of both the arithmetic and logarithmic returns suggest the market perception of the announced consolidations is positive more than half of the time the occurrences are statistically significant.

F. Northrop Grumman

Northrop Grumman made a total of 27 consolidation announcements between January 1990 and December 2006 concerning its consolidation plans with other companies, as shown in Tables 20 and 21.

These event dates and the calculated *t*-statistic for the abnormal returns generated using the arithmetic return on the announcement date (and one day after the announcement) are presented in Table 20. For ease of presentation and reading, the statistical significance of a *t*-statistic (*t*-stat) is only noted if it was at least significant at the 10% level. Blank spaces in the Stat Sig columns represent statistically insignificant findings.

Announce Date	Target	t-Stat	Stat Sig	t-stat day after	Stat sig
4/4/1994	**Grumman Corp.**	**-2.9968**	**0.05%**	**1.0960**	
1/3/1996	**Defense Electronics Business**	**-4.6300**	**0.05%**	**-1.3600**	**10%**
5/5/1997	**Logicon, Inc.**	**-3.5200**	**0.05%**	**0.6461**	
7/3/1997	**Lockheed Martin Corp.**	**19.0300**	**0.05%**	**1.5100**	**10%**
8/10/1998	**Inter-National Research Ins.**	**-1.4800**	**10%**	**-0.9221**	
8/21/1998	**1,415 Acre Radar Test Site**	**1.1710**		**1.8810**	**5%**
3/11/1999	**Information Systems Division**	**0.1168**		**1.7620**	**5%**
5/19/1999	Data Procurement Corp, Inc.	0.5927		0.7901	
5/27/1999	**Ryan Aeronautical**	**-1.2880**	**10%**	**-0.0570**	
11/12/1999	Navia Aviation AS	0.4804		0.7028	
4/10/2000	Explosive Ordnance Disposal	0.9198		0.7115	
6/12/2000	**Comptek Research, Inc.**	**-2.2370**	**2.5%**	**-1.3560**	**10%**
9/6/2000	Federal Data Corp.	-0.0848		-0.2766	
9/18/2000	Sterling Software US, Inc.	0.2461		-0.7786	
12/21/2000	**Litton Industries, Inc.**	**-0.3499**		**-5.2799**	**0.05%**
4/6/2001	Solystic SA	-0.3370		-1.0378	
4/20/2001	**Electronics & Information Systems**	**-0.7825**		**-1.8900**	**5%**
5/9/2001	**Newport News Shipbuilding I**	**-1.6861**	**5%**	**0.9126**	
2/22/2002	**Northrop Grumman Space & Missiles**	**-2.8993**	**0.05**	**-0.4274**	
12/6/2002	TRW Marzocchi Automotive	0.8445		0.0514	
12/18/2002	**Fibersense Technology Corp.**	**1.6861**	**5%**	**0.4284**	
7/24/2003	**Xontech, Inc.**	**-1.5262**	**10%**	**0.3121**	
1/31/2005	**Electro Optic Systems Holding**	**-0.3845**		**-1.8900**	**5%**
3/21/2005	Integic Corp.	0.7259		0.7405	
9/21/2005	**Rights to Proprietary Software**	**-2.9708**	**0.05%**	**-1.7982**	**5%**
3/21/2006	CEA Technologies Pty Ltd.	-0.0694		-0.0581	
11/8/2006	**Essex Corp.**	**-2.7992**	**0.05%**	**-0.3440**	

Table 20. Northrop Grumman Arithmetic Return Events: Statistical Significance

In the case of Northrop Grumman, 68% of the announcements resulted in statistically significant abnormal returns when the researcher used the arithmetic returns as the basis for calculating the abnormal return. This was the highest

percentage of events experiencing statistically significant abnormal returns across the five US defense industry contractors analyzed in this case study. Of these statistically significant abnormal returns experienced by Northrop Grumman, 22% were positive, and 78% were negative.

When the researcher used logarithmic returns as the basis for calculating the abnormal return, the percentage of events that experienced a statistically significant abnormal return (in contrast to using the arithmetic returns) decreased. Table 21 contains the *t*-statistics and levels of statistical significance for each event using the logarithmic returns. Only 59% of the announcements resulted in statistically significant abnormal returns when the researcher used the logarithmic returns as the basis for calculating the abnormal return. Of these statistically significant abnormal returns experienced by Northrop Grumman, 19% were positive, and 81% were negative.

Announce Date	Target	t-Stat	Stat Sig	t-stat day after	Stat sig
4/4/1994	**Grumman Corp.**	**-3.0908**	**0.05%**	**1.0784**	
1/3/1996	**Defense Electronics Business**	**-4.7457**	**0.05%**	**-1.3790**	**10%**
5/5/1997	**Logicon, Inc.**	**-3.5079**	**0.05%**	**0.6553**	
7/3/1997	**Lockheed Martin Corp.**	**17.0744**	**0.05%**	**1.5080**	**10%**
8/10/1998	**Inter-National Research Ins.**	**-1.4536**	**10%**	**-0.8943**	
8/21/1998	1,415 Acre Radar Test Site	0.4430		-0.0524	
3/11/1999	**Information Systems Division**	**0.1283**		**1.7530**	**5%**
5/19/1999	Data Procurement Corp, Inc.	0.6044		0.7306	
5/27/1999	**Ryan Aeronautical**	**-1.3066**	**10%**	**-0.5064**	
11/12/1999	Navia Aviation AS	0.4854		0.7112	
4/10/2000	Explosive ordnance disposal	0.9284		0.7199	
6/12/2000	**Comptek Research, Inc.**	**-2.3089**	**2.5%**	**-1.3640**	**10%**
9/6/2000	Federal Data Corp.	-0.0762		-0.2701	
9/18/2000	Sterling Software US, Inc.	-0.2404		-0.7716	
12/21/2000	**Litton Industries, Inc.**	**-0.4011**		**-5.4890**	**0.05%**
4/6/2001	Solystic SA	-0.3306		-1.0300	
4/20/2001	**Electronics & Information Systems**	**-0.7790**		**-1.9230**	**5%**
5/9/2001	**Newport News Shipbuilding I**	**-1.7031**	**5%**	**0.9087**	
2/22/2002	**Northrop Grumman Space & Missiles**	**-3.0809**	**0.05%**	**-0.4517**	
12/6/2002	TRW Marzocchi Automotive	0.8298		0.0621	
12/18/2002	**Fibersense Technology Corp.**	**1.6445**	**5%**	**0.4307**	
7/24/2003	**Xontech, Inc.**	**-1.5430**	**10%**	**0.3194**	
1/31/2005	Electro Optic Systems Holding	-0.4154		-0.2636	
3/21/2005	Integic Corp.	-0.5642		-0.8334	
9/21/2005	**Rights to Proprietary Software**	**-3.0142**	**0.05%**	**-1.8050**	**5%**
3/21/2006	CEA Technologies Pty Ltd.	-0.0694		-0.0581	
11/8/2006	**Essex Corp.**	**-2.8255**	**0.05%**	**-0.3447**	

Table 21. Northrop Grumman Logarithmic Return Events: Statistical Significance

The results produced from using both the arithmetic and logarithmic returns suggest Northrop Grumman's announcements concerning its consolidation plans with other companies did not always result in statistically significant abnormal

returns to its stock price; however, these plans did result in statistically significant abnormal returns more than half of the time. When the abnormal returns were statistically significant, they were overwhelmingly negative. This suggests the market perception of the announced consolidations, when found to be statistically significant, was negative.

V. Conclusion

This case study examines and analyzes whether or not there is a statistically significant reaction in financial markets to the announcements of US defense contractor consolidations (mergers and acquisitions) from January 1990 to December 2006 for the top five US defense industry contractors. Although this analysis is noted as being limited in scope and is not exhaustive, it does suggest several key findings worth noting.

First, the percentage of events from the composite data experiencing statistically significant abnormal returns was 41-42%, whether the arithmetic or logarithmic returns are used in the calculations. This suggests that on average, less than 50% of the announcements of contractor consolidation had an effect on the statistically significant abnormal returns for the stock value.

Second, when the researcher analyzed each individual defense contractor's events using either the arithmetic or the logarithmic returns, four out of five of the contractor percentages of events experiencing statistically significant abnormal returns generate a greater percentage of statistically significant negative abnormal returns than statistically significant positive abnormal returns. This suggests the market's perceived value of the stocks for Boeing, Lockheed Martin, Raytheon and Northrop Grumman decreased in value when their respective consolidation announcements were made between January 1990 and December 2006. This conclusion is generally consistent with information available from that same period of time—suggesting the mergers and acquisitions were accomplished largely due to necessity for survival in the industry.

General Dynamics is the exception in this finding because this defense contractor experiences a much greater percentage of positive statistically significant returns (80%) than negative statistically significant abnormal returns (using the arithmetic returns). General Dynamics also still maintains a greater percentage of

events experiencing positive statistically significant abnormal returns (64%) than those experiencing negative statistically significant abnormal returns (36%) (using the logarithmic returns). This suggests the market's perceived value of the stocks for General Dynamics increased in value when it made consolidation announcements between January 1990 and December 2006. As of 1999, General Dynamics stock was notably regarded as rising for most of the decade of the 1990s (Flanagan, 1999).

Interestingly, of the five US defense contractors referenced in this case, General Dynamics has the lowest percentage of events experiencing statistically significant abnormal returns (28%). These findings related to General Dynamics in the aggregate suggest that many contractor consolidation announcements had no effect on the abnormal returns for the stock value; however, where those abnormal returns are found to be statistically significant, they are more likely to increase rather than decrease.

Third, of the five US defense contractor consolidation announcement events analyzed in this case, Northrop Grumman has the highest percentage of events experiencing statistically significant abnormal returns (67%). This finding suggests the market perception of the consolidation announcements made by Northrop Grumman is usually statistically significant, and where the resulting abnormal returns are statistically significant, the value of Northrop Grumman's stock typically decreases (78% of the time).

Fourth, the overall findings in this case of event studies is rather mixed, suggesting insignificant overall findings. In order to conduct a successful event study, it is imperative for researchers to identify the exact date of the event. This has indeed been accomplished in this case study; however, it is also useful to note that during the 1990-2006 timeframe, these mergers and acquisitions (and the overall consolidation of the US defense industry) had been frequently debated in the political arena—thereby making many of the consolidations anticipated. Such debate can result in wealth effects (i.e., changes in value of stock price) being

gradually incorporated in such a way that the announcement date would have no statistically significant effect on the abnormal returns.

Similar issues were encountered and conclusions drawn in other event studies, particularly those concerning the impact of deposit interest-rate ceilings for thrift institutions (Dann & James, 1982). MacKinlay notes that Larry Dann and Christopher James (1982) decided not to consider a change in 1973 because it was due to legislative action. The study of merger-related regulation announcements (Schipper & Thompson, 1983) is another example of mixed results in event studies. In this case, the results were found to be significant for the major acquiring firm; however, the results were mixed in the sense that some were positive, and others were negative statistically significant changes in the value of the firm.

The case study results underscore the mixed-net effect the announcement date of a proposed merger or acquisition has on the market value for each of the top five defense contractors; the results also provide circumstantial evidence suggesting the level of influence public policy debates can have on the value of a company's stock. Clearly, there is not enough evidence to conclude the public debate of the issue is what caused the mixed results in the event studies; however, this correlation might give policy makers pause to consider the impact of the merger and acquisition debates on wealth effects, should the DoD again need to address the issue in the future.

Many studies have been conducted using the event-study methodology, and the results have shown in some cases that stock prices do respond to new information. The assumption has been maintained that the market responds rationally to such announcements. In contrast, the announcements of the acquisition of publicly traded firms by other publicly traded firms *have not always had a consistently significant beneficial effect* on the shareholder wealth of the acquiring firms (Schipper & Thompson, 1983). Results of this case study not only support the latter assertion and add to the body of research involving event studies concerning such matters, but they also provide Department of Defense and Department of

Justice policy makers with quantifiable and unbiased data to support future policy concerning mergers and acquisitions.

VI. Recommendations for Future Research

A. Expand Study to Include other Defense Contractors

This case of event studies is limited to only five of the aerospace and defense contractors; however, expansion of the research to include other defense contractors would provide a larger data sample from which it would be possible to record trends in the magnitude and frequency of the statistically significant outcomes. A larger sample of defense contractor event studies would then provide a larger pool from which to compare pre- and post-merger trends.

B. Compare Results to Pre- and Post-merger Trends

As mentioned in the introduction, the data gathered from this research can be used as the baseline for comparison when researchers examine pre- and post-merger trends in the respective company's financial performance. When examining the ex post data in light of the market perceptions of the consolidations, researchers are then able to determine whether the market's perception of the merger or acquisition became a reality for the company in question.

This would be a particular area of interest for additional research because there seems to have been (and continues to be) a concern that the wave of consolidation which occurred largely between 1990 and 2000 has adversely affected defense industry contractors. Very little quantifiable data seems to be available, and that which is does not tie it to the market perception of the value (or loss of value) due to the defense industry consolidation.

C. Perform Similar Event Study Analysis on Targets

This case of event studies focused on the top five defense contractors as the primary acquirers in the consolidation announcement events, and it was the acquirer's stock value (abnormal returns) that was analyzed. It would also be

interesting to investigate whether there were statistically significant abnormal returns on the target's stock price on the date the consolidation announcement was made.

An analysis of this kind would be valuable because it would complete the market perspective on the date of the consolidation announcement and explore the market's perception of the value of the acquisition or merger to both the target and the acquirer.

D. Conduct Qualitative Research to Suggest Reason for Statistically Significant Results

The documented press surrounding General Dynamics' acquisition of Anteon is positive and is noted to indicate the US Department of Defense's interest in investing in information technology (Merle, 2005). This particular event was found to be linked to highly statistically significant abnormal stock returns for General Dynamics (Tables 16 and 17 above). Additional qualitative research resulting in revelatory findings like this would provide more in-depth understanding of the events in this study experiencing statistically significant abnormal returns.

E. Perform Robustness Checks

It would be most helpful to find additional indices for the January 1990 and December 2006 timeframe to complete a robustness check. The PHLX defense sector index data is only available from April 2002, through June 2006, and is not comprehensive enough to cover the timeframe of this study. No earlier data was available through online sources like www.yahoofinance.com, and the NPS account to the Bloomberg database did not offer any other alternatives.

Perhaps with additional time, earlier defense-sector index information could be compiled, or better yet, the defense sector index could be constructed for use in the robustness check. Comprehensive robustness checks on the event studies would increase the integrity and fidelity of the data gathered, as well as inferences and conclusions made from that data.

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